IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Nelson, Carl T.

Serial No.: 07/683,549 Examiner: K. Peckman

Date Filed: April 10, 1991 Art Unit: 2102

Invention: SWITCHING VOLTAGE REGULATOR CIRCUIT

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CERTIFICATE OF SERVICE

I hereby certify that this correspondence has been served on Counsel for Applicant by first class mail postage prepaid in an envelope addressed to: Mark D. Rowland, FISH & NEAVE, 1251 Avenue of the Americas, New York, New York 10020 on May 24, 1994.

By: Edward A. Brown

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Honorable Commissioner of
Patents and Trademarks
Washington, DC 20231
ATTENTION: Director Group 210

PROTEST UNDER 37 C.F.R. 1.291

Dear Sir/Madam:

This Protest is filed to identify material prior art and to present grounds for rejection of various claims of the above-identified application. Full consideration of all stated grounds for rejection are respectfully requested so that any claims issuing from the present application are in full compliance with all of the requirements of the United States patent laws.

SUMMARY

By its recent amendment filed March 7, 1994, Applicant seeks patent claims that go beyond the original patent application disclosure and are broadened to cover electronic circuits that were known in the prior art. In particular, claim 89 seeks to cover the current-mode controlled circuit that was known and disclosed by the UC3842. Mounting such a circuit entirely within an integrated circuit was well known as demonstrated by the LAS6302 circuit in which all of the elements of a voltage-mode switching regulator were placed in a single integrated circuit. Claims 82-92 are further directed to combinations of elements such as the use of 5 terminal package, a sleep mode and a bipolar output transistor, all of which were known in the art.

Claims 86-88 and 90-92 are fatally defective for failure to comply with the description requirement of Section 112. Each of these claims adds a component recited as a shutdown terminal. Such a terminal can be found nowhere in Applicant's original patent application. There is neither any mention of such a terminal in the written specification nor is there any illustration in the drawings of a circuit with a so-called shutdown terminal. The original disclosure only teaches the use of the compensation terminal for controlling a shutdown circuit.

The claim language of numerous claims in the application fail to satisfy the requirement of definiteness set forth in Section 112. Claims 16-25, 56-69, 70, 72, 73, 75, 76, 78, 79, 81, 84, 86-88, and 90-92 all refer to a shutdown state where a

current drawn by the integrated circuit is reduced. It is clear from the prosecution history that this language refers to a micro-power sleep mode in which the regulator is totally shut down. However, the claim language by itself should be clarified because it does not clearly state what is being compared to when it states that the current is reduced. A switching regulator has an output that switches between on and off. A higher amount of current flows when the regulator is on. Many prior art circuits are known in which a shutdown state is available in which the outputs are turned off. While the current drawn in this off state is reduced compared to when the switching regulator is on, such a state is clearly not the shutdown state intended to be covered by the claims. While Applicant made this distinction clear in statements during the prosecution, Section 112 requires that the claims themselves be definite and particularly point out the invention.

The Examiner is respectfully requested to make a full consideration of all the prior art references enclosed herewith listed on the enclosed Form PTO-1449, copies of which are enclosed herewith. Rejections called for by the prior art and Section 112 are given below. Following the rejections are a concise statement of the relevance of each of the prior art references.

CLAIM REJECTIONS COMPELLED BY THE PRIOR ART AND THE UNITED STATES PATENT LAWS

1. Claim 89 is anticipated by the publication "UC3842 Provides Low-Cost Current-Mode Control". Every element of the claim is disclosed in the UC3842 publication. A claim chart is provided below which amply demonstrates paragraph-by-paragraph that the claimed circuit is entirely disclosed in the prior art publication. FIGS. 1 and 4 of the UC3842 publication are particularly relevant. The UC3842 integrated circuit is illustrated in FIG. 4. The current-mode control configuration for the integrated circuit is shown in FIG. 1.

Nelson Reissue, claim 89	UC3842
"An integrated circuit for implementing a current-mode switching regulator circuit by connecting the integrated circuit to external components, the integrated circuit comprising:"	UC3842 Provides Low-Cost Current-Mode Control (title).
"at least an input terminal and a ground terminal for connecting the integrated circuit to a source of input voltage and current,"	Input terminal 7 and ground terminal 5 are shown in FIG. 4.
"an output terminal for connecting the integrated circuit to an external inductive or transformer load,"	Output terminal 6 of the UC3842 IC is shown in FIG. 4. The output of the current-mode control circuit in FIG. 1 is the collector of the output transistor. Terminal 6 drives the output transistor. The output transistor is connected to a transformer load.

"a feedback terminal for receiving an external feedback signal proportional to the regulated output voltage of the switching regulator,"	The feedback terminal 2 of FIG. 4 is shown connected to a feedback signal V_o in FIG. 1.
"and a compensation terminal for connection to an external frequency compensation network;"	A compensation terminal 1 is shown in FIG. 4. "The E/A output is available at pin 1 for external compensation, allowing the user to control the converter's closed-loop frequency response" p. 74.
"a power switching transistor structure coupled to conduct current between the output terminal and the ground terminal;"	The power switching transistor is shown in FIG. 1.
"a circuit coupled to the switching transistor structure for varying the on and off duty cycle of the switching transistor in response to a control signal;"	The PWM latch is shown in FIG. 4 and FIG. 1.
"a circuit, including a resistive element coupled in series with a current path in the switching transistor structure between the output terminal and the ground terminal, for generating a current sense signal indicative of the current conducted by the switching transistor;"	R_{sense} is shown in FIG. 1.
"a circuit for generating an error signal indicative of a difference between the feedback signal and a reference signal, and for coupling the error signal to the compensation terminal;"	Error amplifier is shown in FIG. 4 and FIG. 1.

"a circuit for comparing the current sense signal to the error signal and for generating the control signal to turn off the switching transistor when the current sense signal compares in a predetermined way to the error signal to vary the duty cycle of the switching transistor to produce the regulated voltage,"	Current sense comparator is shown in FIG. 4. It is called a PWM comparator in FIG. 1.
"said comparing circuit further being responsive to control signals externally applied to the compensation terminal for (a) limiting peak current conducted by the switching transistor and (b) variably limiting current conducted by the switching transistor as a function of time."	"An upper limit on the peak current can be established by simply clamping the error voltage." P. 73. The error voltage V_{error} shown in FIG. 1 can be set at the compensation terminal 1 as shown in FIG. 4. The current sense comparator of the UC3842 is responsive to a soft start signal as set forth in (b). Means for applying a soft start signal are not required by the claim, but in any case such means were well known as shown at page 1-12 of the 1986 Unitrode Switching Regulated Power Supply Design Seminar Manual.

2. Claim 89 would have been obvious from the UC3842 in view of the LAS6302 described in the 1984 Lambda Semiconductors Applications Handbook. The circuit components of claim 89 are all shown by the current-mode control switching regulator of the UC3842. The LAS6302 demonstrates it is a simple matter of choice as to whether the power switching transistor and current sense resistor are external or internal components.

The LAS6302 is a voltage mode switching regulator. Applicant has admitted that the invention is equally applicable to current-mode control voltage regulators and voltage-mode

switching voltage regulators. At column 18, lines 16-24, the original patent states:

> For example, while the multi-function terminal feature of the present invention has been disclosed in the context of an integrated circuit for use in implementing a current-mode switching voltage regulator, it will of course be understood by those of skill in the art that the invention may be employed to implement a 5-terminal integrated circuit for use with voltage-mode switching voltage regulator topologies having a micro-power sleep mode capability.

All of the components of claim 89 are shown in the LAS6302. These include an input terminal 2, a ground terminal CASE, an output terminal 1, a feedback terminal 6, a compensation terminal 7, a power switching transistor shown with its collector connected to the output terminal 1, a circuit for varying the on and off duty cycle identified as PWM, a current sense resistor, a circuit for generating an error signal identified as ERR, and a comparator identified as C.L. The circuit of the LAS6302 is not implemented as a current-mode control circuit. Therefore, the current sense comparator and the PWM latch of the current mode control system are not implemented as such. However, the LAS6302 is an illustration of the simplicity with which a circuit designer can expand the boundaries of an integrated circuit to include the output transistor and current sense resistor. Thus it is seen as a simple matter of choice as to whether the current-mode controlled regulator of the UC3842 is designed for use with an external output transistor and sense resistor or whether the output transistor and sense resistor are included within the integrated circuit as was done in the LAS6302.

3. Claims 82-85 would have been obvious over the UC3842 in view of the well known practice of putting a voltage regulator into a five-pin package. Five terminal voltage regulators are disclosed by National Semiconductor LM2931 series low drop out regulators, U.S. Patent No. 4,543,522 (Moreau), U.S. Patent No. 4,680,530 (Mashino) and the switching DC to DC microconverters-LSH6300 series as illustrated by the LSH6335P and the LSH 6355P. The electronic switching device of U.S. Patent No. 4,414,478 (Ueda et al.) is also relevant to the common practice of providing an integrated circuit chip having a reduced number of terminals.

As described above with respect to claim 89, all of the elements in claim 82 are found in the UC3842 article. The five terminals, the power switching transistor, the latch for varying the on and off duty cycle, the R_{sense} resistor, the error amplifier, the compensation terminal at the output of the error amplifier, and the current sense comparator are all disclosed in FIGS. 1 and 4 of the UC3842 article. Referring to FIG. 4 of the UC3842, it is a simple matter of design choice to delete the V_{ref} pin terminal 8 which provides the five volt reference for use by other circuits, delete the oscillator time constant terminal setting the time constant internally instead and bring the current sense resistor inside the IC so that a current sense terminal is no longer needed. These three steps reduce the UC3842 to five terminals. The incentive to take these steps to put the UC3842 in a five pin package is clearly illustrated by

the LSH6335P and the LSH 6355P circuits. Both of these are switching regulators packaged with five terminals. As shown in the block diagram of each of these circuits, terminals are deleted for the V_{ref} and the oscillator and the current sense resistor is internal alleviating any need for a current sense terminal. It would have been obvious to similarly change the UC3842 IC to provide it in a five pin package.

Even without considering the LSH circuits, bringing additional components onto the chip, such as the power transistor and current sense resistor, is a matter of choice also demonstrated in the LAS 6302 integrated circuit. By adding the transistor and current sense resistor onto the chip of the UC3842, it becomes instantly apparent that the current sense terminal 3 is no longer needed. The voltage sensed by the resistor is normally connected to the current sense comparator anyway. Therefore, with the resistor on the chip, the terminal is not needed. Circuit designers are often faced with this design choice. For example, in Ueda et al. at column 4, lines 8-11, the patent states:

> Since the terminal 2c or 20b of the detector 3s is commonly connected to the power terminal 2d or 20e, the total number of connecting terminals of the integrated circuit chip may be minimized.

This type of circuit designer's choice is being made when the power transistor and the current sense resistor are added into the chip. A terminal can be deleted. Likewise, it is a matter of design choice to either provide the oscillator with a time constant set by external components or to provide the resistor

and capacitor time constant within the integrated circuit itself. When the resistor and capacitor are internal, the terminal 4 of the UC3842 is no longer needed. Providing the terminal allows the user to select the time constant whereas bringing the resistor and capacitor into the chip provides a final product that is less flexible. As for the V_{ref} terminal, it is not needed internally anyway, it is provided for use by other circuits.

Depending on design choice, the UC3842 circuit can be implemented on a circuit with five terminals, six terminals, seven terminals, eight terminals, or any larger number of terminals. The claims 82-85 merely call for taking the circuit of FIG. 1 in the UC3842 article, putting more of it within the boundary of the IC and deleting the V_{ref} terminal. Five terminal regulators are a commonly selected package as described in the LM2931 series, Moreau, Mashino and the LSH-6300 series. Claim 82's selection of five terminals is a mere matter of choice and does not constitute a nonobvious invention.

Claims 83 and 85 make reference to using the error signal as a threshold for generating a control signal. This is disclosed in the UC3842. In particular, on page 71, the article states "The termination of each pulse occurs when an analog of the inductor current reaches a threshold established by the error signal." Claim 84 also specifies that a control signal applied to the compensation terminal may perform any <u>one</u> of three listed functions. The compensation terminal in the UC3842 can do two of these functions. It can control a limit on the peak current or

variably limit current as a function of time. In particular, at page 73, the article states "An upper limit on the peak current can be established by simply clamping the error voltage." The error voltage is provided at the compensation terminal.

4. Claims 86-88 and 90-92 are invalid for obviousness over the UC3842 in view of Texas Instruments linear integrated circuits type TL496C, 9-volt power supply controller and types RC4193M, RC4193I, RC4193C micro-power switching regulators. These claims are directed to the current-mode controlled switching regulator of the UC3842 with a shutdown mode. As defined in the specification, shutdown refers to "total regulator shutdown into a micro-power sleep mode," (Col. 7, lines 21-22 of the original patent), and "shutdown of integrated circuit 100 to a micro-power sleep mode", (Col. 9, lines 25-26 of the original patent). Referring to column 10, lines 53-57 of the original patent, it there states "shutdown circuit 122 provides a signal to regulator 102 and to generator 120 which deactivates both so that the only current drawn by regulator 100 is a current of 50μA - 100μA necessary to bias shutdown circuit 122."

This type of shutdown for a regulator is described in the Texas Instruments RC4193 as follows:

> The RC4193 will shut off when pin 6 (IC) is below 0.5 volt. The shutoff feature is useful in battery backup applications requiring operation only when the line power is removed. Another use of this feature is connecting a zener diode between pin 6 and the battery line to <u>shut down the regulator</u> whenever the battery voltage drops below a predetermined level (emphasis added).

The data sheet describes the low bias current in the upper left-hand corner as being 135μA. The claimed shutdown is also found in the type TL496C data sheet which states:

> The design of the TL496 allows minimal supply current drain during stand-by operation (125μA). With most battery sources, this allows a constant bias to be maintained on the power supply.

It would have been obvious to one of ordinary skill in the art to add this known shutdown capability to the current-mode controlled regulator of the UC3842. The incentive is present in that both the UC3842 and the Texas Instruments circuits are switching regulators. It is a mere matter of design choice to decide which features one wishes to include in an integrated circuit. Applicant's inclusion in its claim of a shutdown terminal as disclosed by terminal 1 in the type TL496C circuit or the terminal 6 in the RC4193 circuit is well known.

As for claims 88 and 92, using a bipolar transistor as the switching transistor structure is disclosed by the UC3842.

5. Claims 86-88 and 90-92 are unpatentable for failure to comply with Section 112, first paragraph which states "the specification shall contain a written description of the invention..." "The description requirement is found in 35 U.S.C. Section 112, and is separate from the enablement requirement of that provision... It is not necessary that the claimed subject matter be described identically, but the disclosure originally filed must convey to those skilled in the art that Applicant had

invented the subject matter later claimed." In re Wilder, 222 U.S.P.Q. 369, 372 (Fed. Cir. 1984).

Claims 86-88 and 90-92 all recite an integrated circuit with an input terminal, a ground terminal, an output terminal, a feedback terminal, a compensation terminal and a shutdown terminal. There is absolutely no disclosure in the original patent to support the recitation of a "shutdown terminal" in the claims. Moreover, the invention of the original patent application has five terminals, not six as now claimed. The original application has been carefully reviewed and there does not appear even once the words "shutdown terminal". A thorough examination of the circuit drawings fail to reveal a shutdown terminal. The original application most clearly describes that shutdown is to be performed through the compensation terminal. Applicant is clearly attempting to patent a circuit that is not his invention. These claims blatantly violate the description requirement of Section 112 and are a bold attempt to patent circuits that Applicant did not invent.

6. Claims 16-25, 56-69, 70, 72, 73, 75, 76, 78, 79, 81, 84, 86-88 and 90-92 fail to comply with the requirements of Section 112, second paragraph. All of these claims refer to shutting down the integrated circuit whereby current drawn by the integrated circuit is reduced. However, the claims do not explain reduced compared to what. Shutdown is a commonly used term, often used to refer to turning off the outputs of an

integrated circuit. Such a shutdown is disclosed by the UC3842 at p. 77 and is controlled by applying a signal to the compensation pin. During a shutdown, the UC3842 draws less current than it does when the circuit is on. The original patent makes clear that the claims do not refer to merely turning off the output as is done in the UC3842, but rather refers to total regulator shutdown in which the circuit is in a micro-power sleep mode. In this sleep mode, the only current being drawn is 50-100μA needed to bias the shutdown circuit. This is much less current than is being drawn in a shutdown mode as taught by the UC3842 in which the outputs are merely shut off. The claim language should clarify this distinction so as to particularly point out Applicant's invention.

7. Claim 78 is indefinite and confusing as it requires at least two of two choices. This claim gives the appearance of incompleteness as it appears that there is another choice missing from the list. Claim 78 should be amended by deleting the words "at least two of" at column 34, line 15.

CONCISE EXPLANATIONS OF RELEVANCE OF THE PRIOR ART

Enclosed herewith is Form PTO-1449 listing prior art which should be considered by the Examiner. Copies of the prior art references are enclosed herewith. A concise explanation of the relevance of each of the listed references follows.

"UC3842 Provides Low-Cost Current-Mode Control", SGS Power Supply Application Manual, 1985 - The UC3842 discloses the circuit now being claimed in the present reissue application. The current-mode control system illustrated in FIG. 1 shows all of the major elements of the current-mode control circuit being claimed. These include the power switching transistor, the current sense resistor, the error amplifier, the current sense comparator and the PWM latch. In addition, at FIG. 4, a terminal layout is illustrated for a UC3842 integrated circuit for use in a current-mode control system. The compensation terminal at the output of the error amplifier is disclosed. The use of the error voltage at the compensation terminal to limit peak current is described at p. 73 and for use in controlling frequency response is described at p. 74. Use of the compensation pin for shutdown is described at p. 77.

Lambda Semiconductors Applications Handbook, 1984 - At p. 64, the LAS6302 integrated circuit is illustrated in schematic form. The LAS6302 is a voltage-mode controlled regulator. The original patent for which reissue is sought clearly states that voltage-mode switching voltage regulators are relevant at Col. 18, lines 13-24. The LAS6302 is particularly relevant for demonstrating that it was well known at the time to include the power transistor and current sense resistor within a switching regulator integrated circuit.

Linear Integrated Circuits: Types RC4193M, RC4193I, RC4193C Micropower Switching Regulator, Texas Instruments, December, 1982 - This reference describes the use of pin 6 to shut off the RC4193 integrated circuit. A low bias current of 135μA is listed in the upper left-hand corner. It is specifically described that this pin may be used to shut down the regulator.

Linear Integrated Circuits: Type TL496C 9-volt Power Supply Controller, Texas Instruments, December, 1982 - This reference discloses that pin 1 may be used to put the TL496 in a standby operation where the current drain is reduced to 125μA.

National Semiconductor LM2931 Series Low Drop Out Regulators, 1984 - This reference discloses the use of a 5 lead TO-220 power package for a low drop out regulator circuit.

Unitrode Switching Regulated Power Supply Design Seminar Manual, 1986 - This manual explains how to achieve soft start using the error amplifier output known in the present application as the compensation terminal. Soft starting variably limits the current over time. An RC network is used to provide the time constant.

Switching DC-TO-DC Microconverters-LSH6300 Series Preliminary - This reference was cited by Applicant during the prosecution of the original patent on July 31, 1987. This reference discloses a switching regulator implemented in a TO-220 style 5 pin package.

Data Sheet, "Lambda Switching Regulations, LSH6335P 3 AMP DC-TO-DC Microconverter," Lambda Semiconductors Databook, Vol. I 1988, p. 25-28 - This reference provides a block diagram of an integrated circuit believed by Applicant to have been on sale prior to the November 18, 1986 filing date of the original patent. Applicant previously disclosed this reference on June 28, 1991 in this application. The LSH6335 circuit is a voltage-mode switching regulator in a five-pin package. The circuit deletes the V_{ref} and the oscillator time constant terminals. The current sense resistor is packaged internally thereby alleviating any need for a current sense terminal.

Data Sheet, "Lambda Switching Regulations, LSH6355P 3 AMP DC-TO-DC Microconverter," Lambda Semiconductors Databook, Vol. I 1988, p. 29-32 - This reference provides a block diagram of an integrated circuit believed by Applicant to have been on sale prior to the November 18, 1986 filing date of the original patent. Applicant previously disclosed this reference on June 28, 1991 in this application. The LSH6355 circuit is a voltage-mode switching regulator in a five-pin package. The circuit deletes the V_{ref} and the oscillator time constant terminals. The current sense resistor is packaged internally thereby alleviating any need for a current sense terminal.

U.S. Patent No. 4,084,312 (Kirk et al.) - Kirk et al. discloses a 5 pin integrated circuit package.

U.S. Patent No. 4,414,478 (Ueda et al.) - Ueda et al. discloses an electronic switch. Col. 4, lines 8-11, of this

patent recognizes that number of terminals in an integrated circuit can be reduced by removing terminals which are commonly connected to one another.

U.S. Patent No. 4,543,522 (Moreau) - Moreau discloses a low drop out voltage regulator implemented on an integrated circuit with 5 terminals.

U.S. Patent No. 4,680,530 (Mashino) - Mashino discloses a voltage regulator implemented in an integrated circuit having 5 terminals.

Respectfully submitted,

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